(12) UK Patent Application (19) GB (11) 2 095 529 A

(21) Application No 8204352
(22) Date of filing
15 Feb 1982
(30) Priority data
(31) 373811
(32) 25 Mar 1981
(33) Canada (CA)
(43) Application published
6 Oct 1982
(51) INT CL³ A23L 1/176
(52) Domestic classification
A2B 315 403 603 604
625 660 702 730 740
760 765 CB
(56) Documents cited
GB A 2039206
GB 1556034
US 3041176
(58) Field of search
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(54) Manufacture of bread crumb-like product

(57) Farinaceous product particles having properties comparable to those of bread crumbs are formed by continuously mixing the components with gaseous leavening agent in a plug flow mixer, extruding dough from the mixer through a plurality of openings; cutting the extruded dough into particles, heating the dough particles to surface dry the particles and stabilize the shape; and subsequently drying them to the desired moisture level. The dried particles are comminuted to the desired crumb size.

ERRATUM

SPECIFICATION NO 2095529A

Front page, Heading (72) inventors *below* Inventors *delete* whole lines *insert* David Victor Dyson, Michael Anthony Fourdrinier Fenn, Kenneth Stephen Darley

THE PATENT OFFICE
27 January 1983

Bas 94625/6

GB 2095529 A

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(54) **Manufacture of bread crumb-like product**

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GB 2 095 529 A

SPECIFICATION

Manufacture of bread crumb-like product

The present invention relates to the manufacture of a particulated leavened farinaceous product which resembles stale bread crumbs in appearance and properties.

Bread particles, in the form of crumbs, are used in a variety of food products, for example, fish coatings, chicken coatings, onion rings, meat patties, and as garnishes. The bread particles are generally produced by baking bread according to conventional yeast leavening procedures, allowing the bread to stale and then comminuting the stale loaf to the desired particle size. The time required for staling is normally about 1 to 3 days, necessitating a large storage space for the loaves while staling occurs, and the rehandling of the same, with interrupted unit processes thus being involved.

It has previously been suggested to utilize added gaseous materials, such as, carbon dioxide, for the leavening of bread in place of yeast leavening. The use of continuous mixers in combination with added gaseous materials also has been described, for example, in U.S. Patent No. 3,041,176 to Baker. In the latter patent, flour and water are premixed to form a slurry, the slurry is transferred by a supply hopper and a pump to a continuous mixer to which gas is introduced to form a continuous dough. The introduced gas is said by this patent to be used to raise the dough in subsequent baking to avoid the use of any yeast or ferment.

While the latter procedure is useful in decreasing substantially the overall baking time for a bread product, as compared to conventional procedures, the premixing of the components to form a slurry is time consuming, the total exclusion of yeast or other ferments prevents the use of the flavour enhancing properties thereof, and the procedure requires a baking step.

The present invention provides an improved procedure for the manufacture of a particulated leavened farinaceous product of characteristics comparable to those of conventional stale bread particles, which enables such particulated farinaceous product to be produced on a continuous basis without the necessity of a baking step.

In accordance with the present invention, there is provided a continuous process for the manufacture of a particulated leavened farinaceous product, which comprises intimately mixing farinaceous product-forming components including flour and water with each other and with at least one gaseous leavening agent in a continuous mixing zone while causing partial gelation of starch material in the farinaceous product-forming components, extruding dough from the continuous mixing zone through a plurality of openings, cutting the extruded dough into discrete dough particles, surface drying the discrete dough particles to stabilize the physical form thereof, and drying the surface-dried particles to a desired moisture level.

The overall procedure involves only a short period of time, when compared to conventional baking processes and staling procedures.

The particles of leavened farinaceous product which are produced in this invention have certain characteristics which render them desirable for a variety of end uses. The particles may have any desired particle size and usually characteristic of bread crumbs. The particles may have any desired particle size and usually characteristic of bread crumbs. The particles have a stable integral coherent shape and an opaque appearance resulting from the partially retrograded nature of the starch, are friable, and have a density of about 19 to about 35 lb/cu.ft. resulting from the porosity of the particles and to some extent, the size of the individual particles, a water absorption capability of abouy 1.5 to about 4 times its own weight, and a shear value of about 1.3 to about 8 kg.

The initial farinaceous product-forming ingredients used in the process may comprise any of the components conventionally used in bread making and itemized under the Standards of Identity, FDA Regulations (U.S.A.) 21 C.F.R. 136.110 to .180 inclusive. The basic components of any dough are flour and water, the term "flour" including farinaceous flours used alone or in combination with other flours and meals, such as, the permitted materials outlined in 21 C.F.R. 137.105 to .350 inclusive, as well as those of legumes, rye, sorghum and rice.

Varying quantities of components may be used, usually including shortening and salt in varying proportions, depending on the characteristics desired in the product and the flour used. Other farinaceous product-forming components which may be used include sugar, and oxidizing, maturing and improving agents, such as, potassium bromate, azodicarbonamide, cysteine hydrochloride and ascorbic acid.

Yeast and amylolytic or proteolytic enzymes also may be included, to modify texture and flavour in the product, as described in more detail below. Emulsifiers and cell-wall improvers may be used.

Yeast is conveniently used for leavening purposes in bread-making. In this invention, yeast may be used, as a flavour enhancer for the farinaceous product rather than for leavening purposes, leavening in this invention being achieved by the use of gaseous materials, such as, carbon dioxide, nitrogen, air, or mixtures of gases.

As mentioned above, the various proportions of the farinaceous product-forming ingredients depend on the properties desired, the flour used and also on the nature and choice of the components. One suitable composition of ingredients, exclusive of water, which is utilized, in this invention, as a dry mix, includes:

Wheat flour	100 parts by weight
Shortening	up to about 8% by weight of flour
Salt	up to about 5% by weight of flour

Another suitable composition of ingredients also used as a dry mix in this invention, utilizing a mixture of flours, may comprise:

Wheat flour	75 parts by weight
Rye flour	25 parts by weight
Shortening	up to about 8% by weight of total flour
Salt	up to about 4% by weight of total flour

In addition, one or more of the following optional components may be present, based on the weight of flour:

Yeast	0 to about 4% by weight
Sugar	0 to about 6% by weight
Yeast food	0.2 to about 0.35% by weight, when yeast is present
Protease	0 to about 85,000 H.U. per 100 lb. flour
Amylolytic enzyme	0 to about 6,000 SKB units/100 lb. flour
Mono and/or diglycerides	0 to about 2% by weight
Hydrolyzed wheat starch	0 to about 5% by weight
"Tween" Surfactant	0 to about 0.75% by weight

Flavour-enhancing and/or texture-modifying premixes may be used to control the product flavour. Such premixes are formed from the above optional components.

Preferred flavour-enhancing mixes for use in this embodiment of the invention may be formed by providing a yeast slurry comprising, based on the weight of total flour:

Yeast	about 1.5 to about by% by weight
Sugar	about 0.05 to about 0.5% by weight
Water	about 10 to about 25% by weight

and utilizing this slurry as an additive to the other farinaceous product-forming materials.

Such slurry also may be used to provide texture modifications to the end product. In this case, the slurry is mixed with a liquid enzyme mixture comprising, based on the weight of total flour:

Amylolytic enzyme	about 1250 to about 6000 SKB Units/100 lb. flour, and/or
Proteolytic enzyme	about 25,000 to about 85,000 H.U./ 100lb. of flour
Yeast food	about 0.25 to about 0.32% by weight
Sugar	about 1 to about 5% by weight
Water	about 30 to about 35% by weight
Flour	about 5 to about 20% by weight

The resulting brew is fermented at a temperature of about 75°F to about 105°F for about 30 to about 90 minutes.

The yeast slurry is used in this embodiment in association with such additional water as may be required to provide the desired overall moisture content and with a dry mix comprising, by weight of total flour:

Flour	about 80 to about 95% by weight
Salt	about 1.0 to about 7% by weight
Shortening	up to about 8% by weight

The presence of in situ salt in crumbs is advantageous in certain end uses and high levels of salt are attainable in this invention, since high concentrations do not adversely interfere with the leavening. This contrasts markedly with conventional bread-forming procedures wherein salt concentrations above about 2% by weight decrease the leavening action of the yeast, thereby limiting the quantity of salt which can be incorporated into the final bread crumbs.

In the process of this invention, the farinaceous product-forming ingredients are fed to inlets at one end of a continuous mixing zone capable of plug flow therethrough. The mixing zone may take the form of an elongate screw-type mixer-extruder, suitably modified to provide the required processing conditions therein. The farinaceous product-forming components are fed to one end of the mixer in relative proportions suitable to provide an overall moisture content of intermixed components of about 30 to about 50% by weight, preferably about 37 to about 43% by weight. The dry mix, water, and any yeast slurry, are usually separately fed to the mixer.

Within the mixing zone, the farinaceous product-forming components are continuously intermixed while they are conveyed from one end of the mixing zone to the other, over a time period of about 15 to about 100 seconds, preferably about 20 to about 50 seconds.

A plurality of spaced gaseous inlets is provided along the length of the mixing zone and a gaseous material, or mixture of gaseous materials, is injected into the mix through the openings. Carbon dioxide usually is used, often in admixture with nitrogen, as the gaseous material, although other materials may be used, including air and oxygen. The total gas fed to the mixing zone is in the range of about 1 to about 30 SCFH, preferably about 8 to about 12 SCFH, per 100 lbs. of dough.

The farinaceous product-forming components and the injected gas are subjected to high shear forces within the mixing zone, sufficient to cause simultaneous uniform mixing of the components and dispersion of the inert gas throughout the mix. The work is done on the dough within the mixing zone varies from about 15 to about 40 watt hr/lb of dough, preferably about 20 to about 30 watt hr/lb.

The mix of farinaceous product-forming components and inert gas is heated within the mixing zone for at least a major proportion, typically about 75%, of the length of the mixing zone to cause partial gelation of starch material contained in the farinaceous product-forming components. The temperature in the mixing zone is maintained sufficiently high that the heat applied combined with that resulting from the high shear mixing results in a dough emerging from the mixing zone having a temperature of about 90° to about 210°F, preferably about 130° to about 170°F, to achieve the partial gelation.

The dough resluting from the operations in the mixing zone is extruded therefrom under a back pressure which is usually in the range of about 200 to about 600 psig, and is preferably in the range of about 250 to about 400 psig, achieved by suitable design of the extrusion die.

The operations effected in this way in the mixing zone ensure that the final farinaceous product will have the properties of stale bread crumbs and no holding time is required at any stage of the process.

In this invention, therefore, the flour and water are separately fed directly to the mixer, the farinaceous product-forming components are conveyed in plug flow manner through the mixing zone while leavening gas is injected into the mix at a plurality of spaced locations, the flour, water and gas are thoroughly intermixed under critical high shear, temperature and back pressure conditions, and the dough-forming process is rapidly completed.

In a preferred embodiment of the present invention, the very short overall mixing time permits direct control to be exercised over the flavour of the final product, by the use of a yeast-based slurry added directly to the mixer at the upstream end.

The dough which is formed by this process contains trapped gaseous material which expands on leaving the mixer. Exit from the mixer is accomplished through a die containing a suitable number of orifices through which the dough passes. The cross-section of the orifices is usually rectangular and about 1/2 to about 1" in dimension but may be of any other desired geometry. The dough is cut from the face of the die to produce dough pieces between about 1/16 and about 1/2" in thickness, preferably between about 1/16 and about 3/16 inch and preferably about 1/2 to about 3/4" in cross-section.

The dough pieces are transported to a conventioanal forced air dryer using a hot air suction or pressure lift. The air lift temperature ranges from about 180 to about 300°F preferably about 230° to about 290°F. The hot air in the lift assists drying by preheating the dough pieces and causing surface drying enabling the pieces to remain as discrete particles on the drier bed. Without the hot air lift there is a tendency for the particles to agglomerate and form a solid

sheet on the dryer bed which hinders air flow.

After drying to the desired moisture, usually less than about 10 wt.%, the dough pieces are comminuted to a suitable size for use, usually less than about 5 mm.

The invention is illustrated by the following examples:

Example 1

An initial dry mix containing the following ingredients was prepared:

Component	*% by weight*
Hard wheat flour	47.853
Rapido 80*	23.926
Pastry flour	23.926
Shortening	2.871
Seasoning	1.424
	100.00

*Rapido 80 is a commercially available bread flour.

The dry mix was fed into one end of the extruder at 4.7 kg/min. Water was added to the same end of the extruder at 1.03 kg/min., 31% of which was added in a preconditioning screw and the remaining 69% at the start of the extruder. In addition a yeast brew consisting of:

Yeast	5.44	kg
Water	60	kg
Dextrose	1	kg

was metered in at the one end of the extruder at a rate of 1 litre/min. to give a total moisture content of 39% .

The components were continuously intermixed during passage from one end of the extruder to the other over a period of about 20 seconds. Carbon dioxide was fed into the extruder at 3 different locations at the rate of 10.5 SCFH/100 lb. dough while the extruder was heated to result in a dough temperatue of 130°F at the exit. Work was applied to the dough during formation thereof and passage through the extruder of 27 watt hr/lb and a back pressure of 300 psig existed at the outlet orifice.

The dough was extruded through rectangular openings dimensioned 5/8 × 7/8 inch and cut into particles of length of 3/16 inch. These particles were conveyed by means of an upflow of hot air at a temperature of 280°F for about 3 seconds to surface dry the wet particles. The surface dried non-sticky dough particles were then dried by conventional hot air drying at a temperature of about 300°F to a moisture content of less than about 10 wt.%.

The dried dough particles had the properties set forth in the following Table I:

TABLE I

Bulk density	22.5 lb/ft^3
Absorption	3.43 × own weight
Shear	3.10 kg

Example 2

An initial dry mix containing the following ingredients was prepared:

Component	*% by weight*
Pastry flour	71.0
Hard wheat flour	23.25
Shortening	3.0
Salt	2.5
Atmul 500*	0.25
	100.00

* A mixture of mono- and di-glycerides sold by Atlas Chemical Company.

The dry mix was fed into the one end of the extruder at 6.6 kg/min. Water was added at the same end at 2.78 litres/min; 10% of which was added in the preconditioning screw and the remaining 90% at the start of the extruder, to provide a moisture content of 39 wt.%.

The components were continuously intermixed during passage from one end of the extruder to the other over a period of about 20 seconds. Carbon dioxide was fed into the extruder at

three locations under 150 psi pressure at a rate of 4.3 SCFH/100 lb. of dough. The extruder was heated to give a dough exit temperature of 150°F. Work was applied to the dough during formation thereof and passage through the extruder of 21 watt hr/lb. and a back pressure of 300 psig existed at the outlet orifice.

The dough was extruded through rectangular openings of diameter 5/8 × 7/8 inch and cut into particles of length 1/8 inch. These particles were conveyed by means of a flow of hot air at a temperature of 280°F for about 3 seconds to surface dry wet particles. The surface-dried non-sticky dough particles were then dried by conventional hot air drying at about 300°F to a final moisture of less than about 10 wt.%.

The dried dough particles had the properties set forth in the following Table II:

TABLE II

Bulk density	25 lb/ft^3
Absorption	3.1 × own weight

In summary of this disclosure, the present invention provides a unique procedure for the preparation of comminuted farinaceous product having properties comparable to stale bread particles which involves only a very short overall period of time. Modifications are possible within the scope of the invention.

CLAIMS

1. A continuous process for the manufacture of a particulated leavened farinaceous product, which comprises intimately mixing farinaceous product-forming components including flour and water with each other and with at least one gaseous leavening agent in a continuous mixing zone while causing partial gelation of starch material in said farinaceous product-forming components, extruding dough from the continuous mixing zone through a plurality of openings and cutting the extruded dough into discrete dough particles, surface drying the discrete dough particles, surface drying the discrete dough particles to stabilize the physical form thereof, and drying the surface-dried particles to a desired moisture level.

2. A process as claimed in claim 1 in which the farinaceous product-forming components are fed to the continuous mixing zone in quantities to provide a total moisture content of 30 to 50% by weight.

3. A process as claimed in claim 2 in which the moisture content is 37 to 43 wt.%.

4. A process as claimed in any one of claims 1 to 3, in which the farinaceous product-forming components are advanced in plug flow manner through the mixing zone in 15 to 100 seconds.

5. A process as claimed in claim 3, in which the components are advanced throught the mixing zone in 20 to 50 seconds.

6. A process as claimed in any one of claims 1 to 5, in which the gaseous leavening agent is introduced to the farinaceous product-forming components at a plurality of locations during passage of the components through the mixing zone at a gas flow rate of 1 to 30 SCFH/100 lb of farinaceous product-forming components.

7. A process as claimed in claim 6, in which the gas flow rate is 8 to 12 SCFH/100 lb of farinaceous product-forming components.

8. A process as claimed in any one of claims 1 to 7, in which the farinaceous product-forming components and introduced gasous material are subjected to conditions of high shear within the mixing zone such that the work done on the materials within the mixing zone varies from 15 to 40 watt hr/lb of farinaceous product-forming components to cause mixing of the components and distribution of gaseous material within the mixture.

9. A process as claimed in claim 8, in which the work applied is 20 to 30 watt hr/lb of farinaceous product-forming components.

10. A process as claimed in any one of claims 1 to 9 in which the partial gelation of the startch material is achieved by subjecting the farinaceous product-forming components and introduced gaseous material to an elevated temperature within the mixing zone during at least a major proportion of the time of passage through the mixing zone.

11. A process as claimed in any one of claims 1 to 10, in which the extruded dough has a temperature of 90° to 210°F.

12. A process as claimed in claim 11, in which the dough temperature is 130° to 170°F.

13. A process as claimed in any one of claims 1 to 12, in which the farinaceous product-forming components are subjected to a back pressure of 200 to 600 psig.

14. A process as claimed in claim 13, in which the back pressure is 250 to 400 psig.

15. A process as claimed in any one of claims 1 to 14, in which the dough is extruded from the mixing zone through a die having a plurality of openings therein having a maximum diameter of $\frac{1}{2}$ to 1 inch and the dough extruded through the plurality of openings is cut into discrete dough particles of 1/16 to $\frac{1}{2}$ inch in length.

16. A process as claimed in claim 15, in which the openings are rectangular shaped and have a dimension of 1/2 to 1 inch and the dough is cut to lengths of 1/16 to 3/16 inch.

17. A process as claimed in any one of claims 1 to 16, in which the surface drying of the dough particles is effected by subjecting the discrete dough particles to a flowing air stream having a temperature of 180° to 300°F.

18. A process as claimed in claim 17, in which the flowing air stream has a temperature of 230° to 290°F.

19. A process as claimed in any one of claims 1 to 18, in which the surface-dried particles are dried to a moisture level of below 10% by weight.

20. A process as claimed in any one of claims 1 to 19, in which the gaseous leavening agent comprises carbon dioxide.

21. A process as claimed in any one of claims 1 to 20, in which the farinaceous product-forming components include salt in a concentration of up to about 7% by weight of flour.

22. A process as claimed in any one of claims 1 to 21, in which the farinaceous product-forming components, exclusive of water, comprises:

Flour	100 parts by weight
Shortening	up to 8% by weight of flour
Salt	up to 5% by weight of flour

23. A process as claimed in any one of claims 1 to 21, in which the farinaceous product-forming components, exclusive of water, comprise:

Wheat flour	75 parts by weight
Rye flour	25 parts by weight
Shortening	up to 8% by weight of total flour
Salt	up to 4% by weight of total flour

24. A process as claimed in claim 22 or 23, in which the farinaceous product-forming components further contain at least one further component selected from:

Yeast	0 to 4% by weight
Sugar	0 to 6% by weight
Yeast food	0.2 to 0.35% by weight when yeast is present
Protease	0 to 85,000 H.U. per 100 lb. of flour
Amylolytic enzyme	0 to 6000 SKB units per 100 lb. of flour
Mono and/or diglycerides	0 to 2% by weight
Hydrolyzed wheat starch	0 to 5% by weight
Nonionic surfactant	0 to 0.75% by weight

25. A process as claimed in claim 24, in which a flavour-enhancing premix is incorporated in the farinaceous product-forming components by utilizing a slurry comprising, based on the total weight of flour:

Yeast	1.5 to about 3.5 by weight
Sugar	0.05 to 0.5% by weight
Water	10 to 25% by weight

26. A process as claimed in claim 25, in which the slurry is mixed with a liquid enzyme mixture, comprising, based on the total weight of flour:

Amylolytic enzyme	1250 to 6000 SKB units per 100 lb. of flour, and/or
Proteolytic enzyme	25,000 to 85000 H.U. per 100 lb. of flour
Yeast food	0.25 to 0.32% by weight
Sugar	1 to 5% by weight
Water	30 to 35% by weight
Flour	5 to 20% by weight

and the mixture is fermented at a temperature of 75°F to 105°F for 30 to 90 minutes before incorporation in the farinaceous product-forming components.

27. A process as claimed in any one of claims 1 to 26, including comminuting the dried particles to a desired particle size.

28. A continuous process for the manufacture of a particulated leavened farinaceous product substantially as hereinbefor described with reference to any one of the Examples.

29. Particulated farinaceous product whenever prepared by a process as claimed in any one of claims 1 to 28.

30. Particulated farinaceous product of stable integral coherent shape, which are opaque and friable, and have a density of 19 to 35 lb/cu.ft., a water absorption capability of 1.5 to 4 times its weight, and a shear value of 1.3 to 8 kg, whenever prepared by a process as claimed in any one of claims 1 to 28.

Printed for Her Majesty's Stationery Office by Burgess & Son (Abingdon) Ltd.—1982.
Published at The Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.